DEVELOPMENTAL CYCLE OF CLADONEMA RADIATUM VAR. MAYERI PERKINS REARED IN THE LABORATORY

BULLETIN OF THE MARINE BIOLOGICAL STATION OF ASAMUSHI,
VOL. VIII, NOS. 2, 3 and 4. 1957

DEVELOPMENTAL CYCLE OF *CLADONEMA RADIATUM* VAR. *MAYERI* PERKINS REARED IN THE LABORATORY*

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(With one figure and 2 plates)

The medusae of the material used in this investigation are commonly found at Asamushi near where *Sargassum* thrives in summer. We identified our material as *Cladonema radiatum* var. *mayeri* Perkins based on Uchida's (1927) description of the medusa, though some individual differences were observed. We carried out the investigation on the developmental cycle of this variety by the method of rearing from egg to medusa in the Petri dish. Bronne (1897 and 1907), Rees and Russell (1937) and others used special apparatus in rearing the hydroid of certain medusae. The hydroid stage or medusa stage of this variety required no special apparatus for rearing in this investigation.

Before going further we thank Mr. H. Tsujimura of the Biological Laboratory of the Imperial Household for his kind information concerning the kind of food applied in rearing.

MATERIAL AND METHOD

From late June to the end of August in 1956, the medusae of *Cladonema radiatum* var. *mayeri* Perkins were collected by the plankton net from the sea area off the Marine Biological Station at Asamushi where *Sargassum* and other algae are abundant. When the mature medusae were placed in Petri dishes over night, we could find many developing embryos on the bottom of the glass. These medusae caught the young larvae of *Artemia salina*, and liberated many eggs almost every night. The hydroids which developed from the planulae

* Contributions from the Marine Biological Station of Asamushi, Aomori Ken, No. 227.

could be reared by the young larvae of *Artemia salina*. The sea water of the rearing dishes was renewed every day, and sometimes the surfaces of the bottoms of the dishes were cleaned by a wooden needle carefully. The dishes were placed on the table in summer, but from autumn according to the fall of temperature they were kept in a thermostat at a temperature which was kept at 20–23°C. The investigations of the hydranth, colony and medusa were carried out on the materials which developed from the liberated eggs, and also on a small colony found on the surface of a piece of a stone which was collected from the seashore near the Station, and on two colonies found on two shells of the living *Pecten yessoensis* in an aquarium of the Asamushi Aquarium.

OBSERVATIONS

a) *Development of the egg to the hydroid stage.* The medusae of this variety could be collected by the plankton net during two months from the end of June to that of August in 1956 near the Station. In the early half of this season, it seemed difficult for the medusae to liberate eggs soon after they were collected, and they needed to be reared several days with the larvae of *Artemia salina* until they became mature. In the later half of the season, it was easy to obtain the eggs from the medusae soon after they were collected. When about ten medusae were placed over night in a Petri dish, we could find many embryos in the blastula stage the next morning. These embryos were 0.08 mm in diameter, and had mucous surfaces with which they were attached on the bottom of the glass vessel (Pl. I, b). When the mother medusae in the vessels were removed and the sea water was renewed every day, the embryos developed to the swimming planulae after about two days. The planula is fig-shaped, and measures about 0.09 mm in long axis and about 0.08 mm in short axis. The peripheral zone of the planula is transparent and the inner zone is dark orange in colour (Pl. I, c). They swim by rotating motion along the long axis, and with the dull pole of the planula at the front. The period of the planula stage was not constant in our investigation, but most of them attached to the bottom of the glass vessel within two days and some of them within eight days when the planulae were transferred to another vessel. After about four days of attachment of the planula, we could observe the young hydroid stage. The young hydranth was developed at first as a long process from the attached and flattened planula, then usually a verticil of four long tentacles was formed. But there were many cases in which three tentacles were formed. A hydranth of about eight days old measured about 0.15 mm in length, and about 0.05 mm in width. A tentacle was about 0.07 mm in length (Pl. I, d).

b) *Hydroid stage.* About 20 days after the attachment of the planula, a hydrorhiza was formed as a long stolon in one direction from the root of the

hydranth (Pl. I, e). The second hydranth was formed at the terminal end of the stolon when it reached about 1.2 mm in length (Pl. I, f). After the appearance of the first and the second hydranths, the second stolon, in one type, appeared from the initial hydranth in the opposite direction to the first stolon, then the third hydranth appeared on the distal end of the later stolon. In the other type, the second stolon arises from the second hydranth along the same direction as the first stolon, then the third hydranth forms on its distal end. In general the fundamental linear colony is formed in the above mentioned way

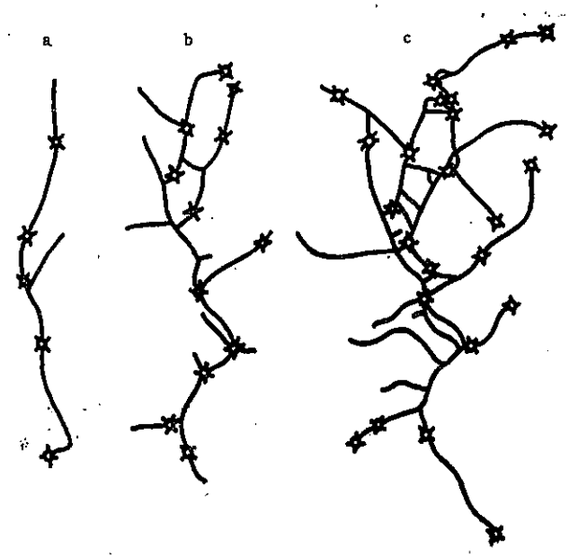

Fig. 1. Formation of a colony of *Cladonema radiatum* var. *mayeri* Perkins. ×10.
a. A new linear colony with five hydranths.
b. Same colony, after 10 days.
c. Same colony, after 13 days.

until four or five hydranths appear (Fig. 1, a). Then the new stolons which are linear or vertical to the initial one were added gradually from each of those hydranths in the early stage, but branches also appeared vertically from the stolons themselves (Fig. 1). According to the elongation of the stolon chains the stolons began to curve irregularly at their distal parts and finally the old colony showed a round outline (Fig. 1, Pl. I, g and h). The stolons grew keeping close contact with the bottom surface of the dish and therefore plane colonies appeared (Pl. I, g). In the colony about two months after the initial hydranth had appeared, new stolons were added also vertically towards the upper direction from the bases of the older hydranths near its central part. In

these old colonies, some hydranths were observed to disappear. On September 20th, the two months old colony was about 3.0–3.5 cm in diameter, and about 160 hydranths were counted in it.

c) *Development of medusa.* On August 18th the first bud of the medusa was found on a hydranth which developed from an egg liberated on July 3rd, or 46 days since liberation of the egg. The hydranth which reached a stage of maturity enabling it to develop the bud of the medusa was about 1.0 mm in height. The bud of the medusa appeared as a small transparent process on a side of the hydranth near the middle part of the column (Pl. I, i). Generally on the hydranth only one bud was observed, but sometimes two buds could be seen, the younger one on the opposite side of the other older one. In a colony which was found on a piece of a stone in 1955, two buds were always observed. About seven to ten days after the appearance of buds, the well differentiated medusae left the column of the hydranth to take to a free swimming life. In the early half of this period, the bud of the medusa developed from a process to a closed sac, the diameter of which was about 0.15 mm (1. I, j). The rudiments of the radial canals were visible as broad and reddish orange lines concentrated toward a point where the bud was connected with the column. The tentacles were differentiated at the margin of the free periphery of the sac (Pl. I, k, Pl. II, l and m). When the differentiation of the organs of the medusa was nearly accomplished, the medusa commenced violent swimming motions although its basal part was still connected with the column (Pl. II, n and o). The medusa just freed from the mother hydranth was about 0.65 mm in height of the bell, and had nine tentacles each of which was provided with a short branch arising from the inner bases of the tentacles (Pl. II, p and q). Each tentacle had five knobs of nematocysts, one on the distal end of the tentacle and the other four arranged almost alternately along the opposite sides of the tentacles. Each short and smooth branch had a knob at its distal end. The radial cansls were very broad, nine in number on the margin of the bell, and as observed in the adult medusa, three pairs among these nine canals gathered into one near the upper center of the bell.

d) *Colonies in rearing.* When a small part of the colony was transferred to another dish, it could be transplanted easily and developed to a new colony. At present about 30 colonies are being reared in the laboratory. Even in the season when liberation of the medusa does not occur in nature, we could obtain them from the reared colonies placed in a thermostat kept at 20–23°C.

REMARKS

We succeeded in rearing colonies of *Cladonema radiatum* var. *mayeri* Perkins by the larvae of *Artemia salina*, and were able to keep many of its colonies in the laboratory. Thus we could observe all stages of the life cycle through a

year. Bronne (1897 and 1907), Rees and Russell (1937) and others used copepods in the plankton as the food in rearing hydroids of certain medusae. We were able to rear the hydroid and medusa by a new food, the young larva of *Artemia salina*, for this variety. These foreign authors used the plunger jar, a continuous current tube or a rocking plate, to supply the fresh water or to make currents in the water in rearing, however, no such special apparatus was needed by us to rear the hydroid or medusa of this variety. The medusa of *Cladonema radiatum* var. *mayeri* Perkins was described by Uchida (1924 and 1927), but the developmental cycle of this variety seems to not have been investigated. In this investigation, the developmental cycle of this variety from the egg to the medusa was observed. Uchida (1927) found the young medusa of this variety at Misaki, and called it the Eelutheria stage of *Cladonema*. According to our investigation, the young medusa which had just left the hydranth resembles Uchida's description and figure, but the radial canal and ring canal of the former is broader than that of the latter. And according to Uchida's description the tentacle has five nematocyst rings but in our observation, the tentacle had five knobs of nematocysts, one on the distal end of the tentacle and the other four arranged almost alternately on the opposite sides and appeared spiral rather than as a ring.

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Plate I. Developmental cycle of *Cladonema radiatum* var. *mayeri* Perkins (1).

a. Adult medusa. The bell is about 3 mm in height.
b. Egg in blastula stage. About 0.08 mm in diameter.
c. Swimming planulae. About two days after the eggs were liberated. About 0.09 mm in long axis, and about 0.08 mm in short axis.
d. Young hydroids which developed from attached planulae.
e. Appearance of stolon from base of hydroid. About 20 days after attachment of planula.
f. First colony composed of two hydranths. Stolon is about 1.2 mm in length.
g. Some colonies formed on the bottom of a Petri dish of 9 cm in diameter.
h. Shadow of a typical colony in a Petri dish of 6 cm in diameter. About three months after the initial hydranth appeared.
i. A small and transparent process of a bud of medusa which appeared on a column of hydranth. A hydranth in this stage is about 1.0 mm in height.
j. A sac-like bud of medusa in the middle stage. About 0.15 mm in diameter.
k. A differentiating bud. A hydranth in *k* is that one of which soon after swallowed a larva of *Artemia salina*.

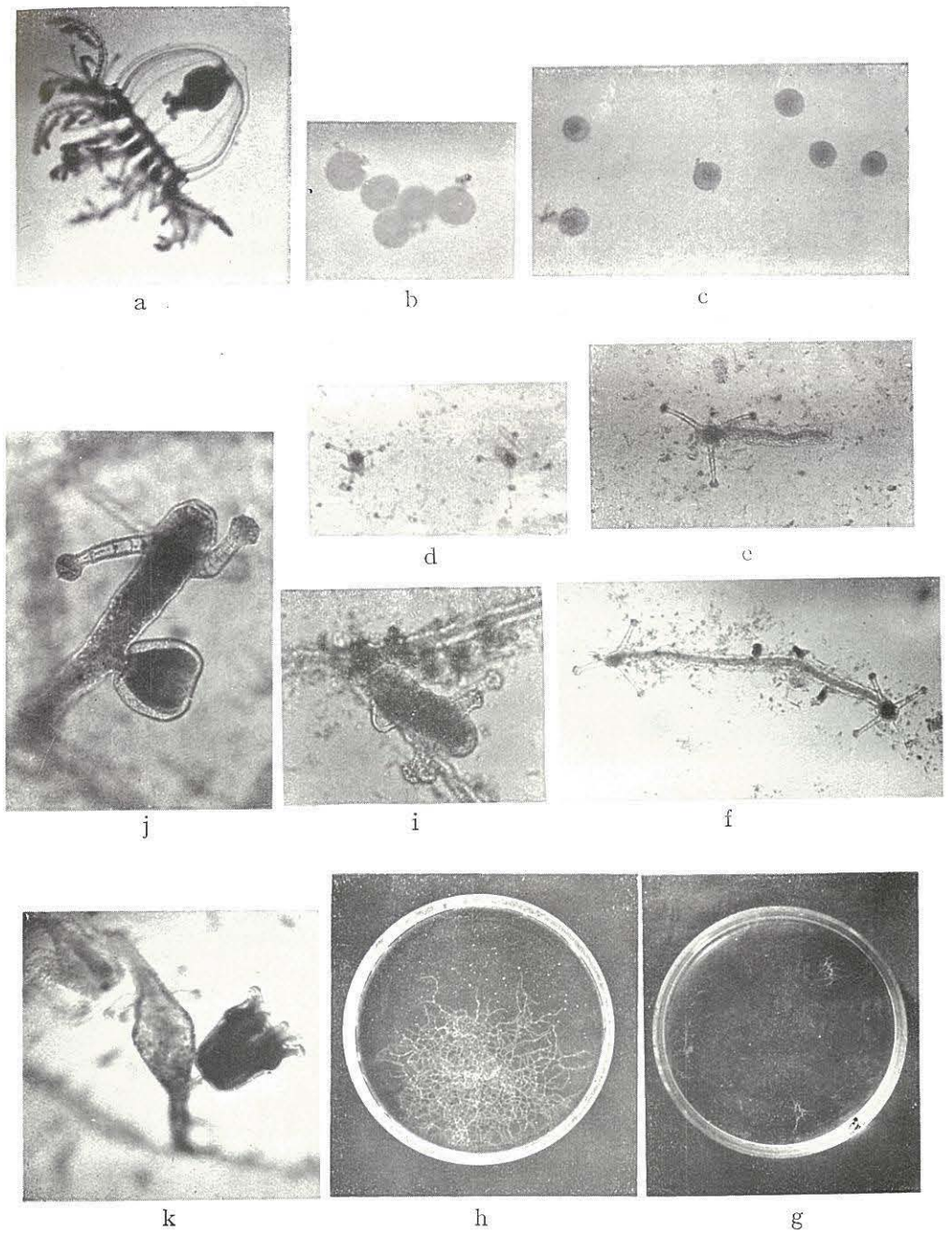
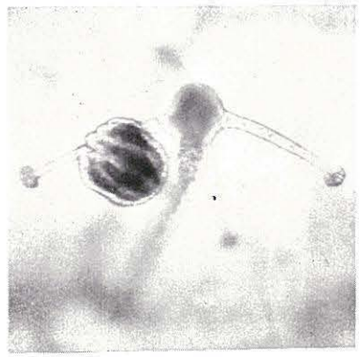


Plate II. Developmental cycle of *Cladonema radiatum* var. *mayeri* Ferkins (2).

l and m. A developing bud of medusa in the later stage. Radial canals, tentacles and other organs are differentiating.

n and o. Medusa bud which has nearly accomplished its differentiation. Medusa in o is making violent swimming motion.

p and q. Young medusa which just escaped from a hydranth. About seven to ten days after the bud appeared. The bell is about 0.65 mm in height, and about 0.85 in width. The tentacle is about 0.65 mm in length.



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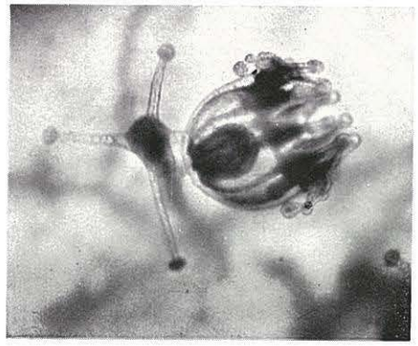

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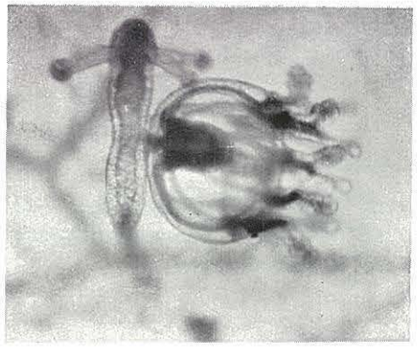

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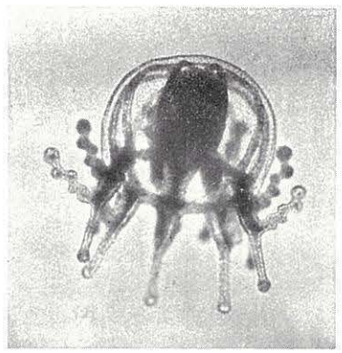

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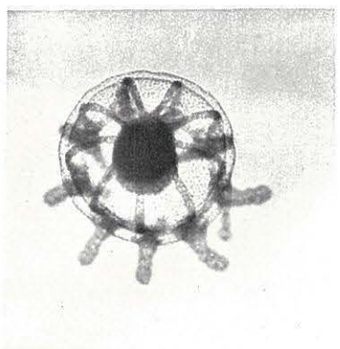

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